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Research Article

EFFECT OF SUBSTITUTING SOYBEAN MEAL WITH DDGS ON NUTRIENT METABOLIZABILITY AND CARCASS TRAITS OF BROILER CHICKEN

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ABSTRACT

A six-week experimental trial was conducted on 520, day-old broiler chicks to determine the effect of replacement of soybean meal with distillers dried grains with solubles (DDGS) along with supplementation of lysine on nutrient metabolizability and carcass traits. Chicks were divided randomly into 13 treatment groups each having 4 replicates and 10 birds in each replicate. The DDGS was added at three levels i.e. 15, 30 and 45%. Lysine was supplemented to each level of DDGS replacements at 0, 0.50, 0.75 and 1%. Dry matter metabolizability of different groups was similar (P<0.05) to the control group up to 30% replacement level of soybean meal with DDGS but reduced significantly (P<0.05) when 45% soybean meal was replaced with DDGS. There was a linear decrease in nitrogen retention and gross energy metabolizability at higher replacement level of soybean meal with DDGS but this reduction was non-significant. Moisture and ether extract of breast and thigh muscles were not affected by the replacement of soybean meal with DDGS and level of lysine supplementation. Crude protein of the breast and thigh muscles was not affected up to 15% replacement level of the soybean meal with DDGS irrespective of level of lysine supplementation. Groups having 30 and 45% soybean meal replaced with DDGS and supplemented with 1% lysine (i.e. groups T_9 and T_{13}) had crude protein in breast and thigh muscle similar (P<0.05) to that of control group, but the dietary treatments having less than 1% lysine supplementation (i.e. groups T_6, T_7, T_8, T_{10}, T_{11} and T_{12}) had significantly lower (P<0.05) crude protein compared to control group. There was no effect of replacing soybean meal with DDGS up to 15% with or without lysine supplementation on carcass traits. And if, lysine was properly balanced in the ration, up to 45% of the soybean could be replaced without any negative effect on carcass characteristics. Treatment groups having 30 or 45% soymeal replacement levels with lysine less than 1% (i.e. groups T_6, T_7, T_8, T_{10}, T_{11} and T_{12}) had lower (P<0.05) dressing, eviscerated percentages as well as lower drawn yield. It was concluded that dry matter metabolizability was not affected up to 30% soybean meal replacement and if lysine was properly balanced in the ration up to 45% of the soybean could be replaced without any negative effect on the carcass characteristics.

Key words: DDGS, lysine, metabolizability, carcass, replacement, soybean meal

The poultry production accounts for 65-70% cost on feed. In India there is a huge gap between demand and availability of the poultry feed. The availability of low-priced, high-quality feeds is critical for the expansion of the poultry industry. The cost of commonly used protein sources in poultry feed e.g. soybean meal, is increasing day by day. As an alternative, cheaper byproducts of comparable quality are being evaluated and incorporated into poultry feeding. Distillers dried grains with solubles (DDGS) is one such product co-produced after extraction of ethanol from fermented grains (Youssef *et al.*, 2013). The non-fermentable components of the grains which are rich in nutrients like protein, fat, fiber, vitamins and minerals are recovered in a highly concentrated form as DDGS (NRC, 1994; Weigel *et al*., 1997; AAFCO 2002). Amani *et al.* (2009) evaluated DDGS as an alternate source of protein in poultry ration with other protein source or after dietary supplementation with lysine. Although, lysine is second limiting amino acid in poultry ration, but it has a profound effect on productivity. Lysine deficiency in starting broiler chicks significantly decreased (P<0.05) development of satellite cells of breast muscle (Tesseraud *et al.*, 1996) and increased protein degradation in pectoralis major muscles due to enhanced expression of m-calpain and cathepsin-B in breast muscles (Tesseraud *et al.,* 2008). The lysine content of DDGS is 0.72% as compared to 2.69% in soybean meal (NRC, 1994) which may be due to damage of this amino acid during drying process (Fastinger *et al*., 2006). In the present study, the effect of replacing soybean meal with DDGS along with supplementation of lysine on the nutrient metabolizability and carcass traits was evaluated in broiler chicks.

MATERIALS AND METHODS

The feeding trial was conducted for a period of 6 weeks in the Department of Animal Nutrition, LUVAS, Hisar. The experiment was duly approved from Institutional Animal Ethics Committee of the university. Five hundred and twenty, commercial day-old vencobb broiler chicks were wing banded, weighed and distributed

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randomly into 52 subgroups (thirteen dietary treatments with four replicates per treatment) of 10 birds each. Birds were vaccinated against Ranikhet disease (F-strain) on 5th and Gumboro disease (IBD) vaccine on 14th day. Basal diet (T_1) was formulated as per BIS (2007) and other diets were formulated by replacing 0, 15, 30 and 45% of the soybean meal with DDGS and fed *ad-lib* throughout the feeding trail. Each DDGS level was supplemented with 0, 0.50, 0.75 and 1% lysine respectively as follows: T_2=15% of soybean meal replaced with DDGS; T_3=15% of soybean meal replaced with DDGS+0.50% lysine, T_4=15% of soybean meal replaced with DDGS+0.75% lysine; T_5=15% of soybean meal replaced with DDGS+1.00% lysine; T_6=30%of soybean meal replaced with DDGS; T_7=30% of soybean meal replaced with DDGS+0.50% lysine; T_8=30% of soybean meal replaced with DDGS+0.75% lysine; T_9=30% of soybean meal replaced with DDGS+1.00% lysine; T_{10}=45% of soybean meal replaced with DDGS; T_{11}=45% of soybean meal replaced with DDGS+0.50% lysine; T_{12}=45% of soybean meal replaced with DDGS+0.75% lysine; T_{13}=45% of soybean meal replaced with DDGS+1.00% lysine. The crude protein ranged from 22.46% to 23.95% in starter rations and from 19.96% to 21.98% in finisher rations. Calculated metabolizable energy ranged from 3000.60 to 3090.02 kcal/kg in starter and from 3192.50 to 3262.36 kcal/kg in finisher ration.

A metabolic trial was conducted during 6th week of growth period to study the balance of nitrogen and energy. One bird from each replicate was randomly selected and transferred to metabolic cages fed with experimental feed. The weigh back feed on the last day of metabolic trial were also analyzed (AOAC, 2007) for dry matter and other nutrients. The availability of nutrients was calculated by dividing the amount of retained nutrients (ingested nutrients- excreted nutrients) with the amount of ingested nutrients.

Nitrogen retention (%)=[(Nitrogen intake –Nitrogen excreted)/Nitrogen intake] x 100

Similarly, the dry matter retention was also calculated. The gross energy of oven dried feed and excreta samples was determined by standard procedure using Bomb Calorimeter. From gross energy values of feed and excreta, the metabolizable energy (ME) was worked out by using the equation given by Hill and Anderson (1958):

$$ME = E_{diet} - E_{excreta} - N \times 8.22$$

Where, ME=Metabolizable energy per kg of dry feed consumed; E_{diet}=Gross energy per kg of dry feed consumed; $E_{excreta}$=Gross energy in excreta per kg of dry feed consumed; and N=Nitrogen retained (g) per kg of dry feed consumed.

Since it was assumed that if protein tissue is oxidized for energy purposes, it would yield uric acid as the sole excretory product; the value, 8.22 was used as the energy value of uric acid per gram of nitrogen retained (Nitrogen correction factor). Gross energy metabolizability (%) was calculated as follows:

Gross energy metabolizability = [Nitrogen corrected metabolizability/ Gross energy of dry feed (kcal/kg)] x 100.

Nitrogen corrected metabolizable energy content of different diets ranged from 3054.51 to 3231.21 kcal/kg. For carcass study, two birds per treatment were selected randomly, at the end of 6th week. Samples of breast and thigh muscles were taken from each of the slaughtered birds and stored in deep-freezer separately for further analysis. These samples were analyzed for moisture, protein and ether extract as per AOAC (2007). The data was analyzed using factorial CRD design as described by Snedecor and Cochran (1994). The nutrient composition (% DM basis) of feed ingredients and ingredient composition (%) in the starter and finisher rations has been presented in Table1 and 2, respectively.

RESULTS AND DISCUSSION

The dry matter metabolizability (Table 3) of the different groups varied non-significantly from the control group up to 30% replacement level of soybean meal with DDGS. The groups with 45% soybean meal replaced with DDGS had significantly lower ($P<0.05$) dry matter metabolizability. It shows that birds utilized dry matter

Table 1
Nutrient composition of feed ingredients (% Dry matter basis)

Ingredient	Dry matter (%)	Crude protein (%)	Ether extract (%)	Crude fiber (%)	Total Ash (%)	Lysine*	Methionine*	ME kcal/kg*
Maize	89.23	9.1	4.1	2.2	1.4	0.18	0.15	3300
DDGS	90.11	44	8.9	9.1	4.9	0.73**	0.50**	2851**
Soybean meal	87.80	44.84	0.9	4.4	5.8	2.57	0.76	2230
Fishmeal	91.00	46	7.2	1.1	21.6	4.14	1.42	2600
Soybean oil	-	-	-	-	-	-	-	8800

*Calculated values (Singh and Panda, 1988); **Waldroup et al. (2007).

Table 2
Ingredient composition (%) of the starter (0-3weeks) and finisher rations (4-6 weeks)

Ingredient (%)	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}
Starter ration													
Maize	55	55	55	55	55	55	55	55	55	55	55	55	55
DDGS	0	4.8	4.8	4.8	4.8	9.6	9.6	9.6	9.6	14.4	14.4	14.4	14.4
Soybean meal	32	27.2	27.2	27.2	27.2	22.4	22.4	22.4	22.4	17.6	17.6	17.6	17.6
Fishmeal	8	8	8	8	8	8	8	8	8	8	8	8	8
Vegetable oil	3	3	3	3	3	3	3	3	3	3	3	3	3
Mineral mixture	2	2	2	2	2	2	2	2	2	2	2	2	2
Feed additives*	430	430	430	430	430	430	430	430	430	430	430	430	430
Lysine (%)	50g	0	0.50	0.75	1.00	0	0.50	0.75	1.00	0	0.50	0.75	1.00
Finisher ration													
Maize	61	61	61	61	61	61	61	61	61	61	61	61	61
DDGS	0	3.75	3.75	3.75	3.75	7.50	7.50	7.50	7.50	11.25	11.25	11.25	11.25
Soybean meal	25	21.25	21.25	21.25	21.25	17.50	17.50	17.50	17.50	13.75	13.75	13.75	13.75
Fishmeal	7	7	7	7	7	7	7	7	7	7	7	7	7
Vegetable oil	5	5	5	5	5	5	5	5	5	5	5	5	5
Mineral mixture	2	2	2	2	2	2	2	2	2	2	2	2	2
Feed additives*	430	430	430	430	430	430	430	430	430	430	430	430	430
Lysine (%)	50g	0	0.50	0.75	1.00	0	0.50	0.75	1.00	0	0.50	0.75	1.00

*Feed additives (g/100kg of feed): 10g ventrimix; 20g meriplex DS; 50g each of CMP I, choline chloride, live sac, biovet YC, lincomix, lysine 200g and methionine150g

less efficiently at higher DDGS level. Thacker and Widyaratne (2007) also reported that metabolizability of dry matter declined with increasing content of wheat DDGS in the diet. Percent nitrogen retention under different dietary treatments varied non-significantly from 59.55% to 61.19%.

The gross energy metabolizability of different treatments (Table 3) was not affected by different level of DDGS level and varied from 60.82% (T_{13}) to 62.46% (T_1). A similar trend was also reported by Thacker and Widyaratne (2007). Compared to maize, gross energy of DDGS is higher but the metabolizability of gross energy is not higher significantly. The concentration of energy in DDGS is greater than that in corn, but because of lower digestibility of energy in DDGS compared to corn, there is no difference in the concentration of digestible and metabolizable energy between DDGS and corn (Stein, 2007).

The moisture content of the breast as well as thigh muscle did not show any significant variation among different dietary treatments and was found to vary from 74.64% (T_3 and T_{13}) to 75.33% (T_{12}) in breast muscle and from 74.98% (T_7) to 75.89% (T_3) in thigh muscle. Fat percentage showed non-significant variation from 5.61 to 6.27% in the breast muscle and from 7.37 to 8.06% in thigh muscle. These results show that as far as the DDGS based diets are nutritionally balanced in terms of amino acids, there is no adverse effect of replacing soybean meal with DDGS up to 45% on the chemical composition of the breast and thigh muscle. These results are in agreement with those found by Choi *et al.* (2008) who reported no negative effect of DDGS supplementation up to 15% on meat qualities. Similarly, Schilling *et al.* (2010) also reported that meat quality was similar among different treatments from 0-12% DDGS inclusion in the diet.

The dietary treatments having 30 or 45% soymeal replaced with DDGS and supplemented with less than 1% lysine i.e. groups T_6, T_7, T_8, T_{10}, T_{11} and T_{12} have significantly lower protein in their breast and thigh muscle (Table 3). The remarkable reduction in the protein deposition in the breast and thigh muscle in treatments having low level of lysine supplementation may probably be because of the reason that lysine is a reference amino acid in the ideal protein concept. Also, the amount of lysine ingested has a direct influence on growth performance as it is used for body protein deposition (Dorigam *et al*., 2013).

There was no negative effect of replacing soybean meal with DDGS up to 15% with or without lysine supplementation on the carcass characteristics (Table 3). And if, the lysine was properly balanced in the ration, up to 45% of the soymeal could be replaced without any negative effect on the carcass characteristics. Percent weight of liver, heart and gizzards under different dietary treatments showed no significant variation. Weight of giblet was found to vary non-significantly from 4.68% to 5.33%. These results are in agreement with the results

Table 3

Dry matter metabolizability, protein content and carcass characteristics of experimental birds under different dietary treatments

Treatments	(%) DM metabolizability	Breast muscle CP (%)**	Thigh muscle CP (%)**	Dressed** (%)	Eviscerated** (%)	Drawn** (%)
T_1	62.80^b±1.03	19.74±0.42^b	18.40±0.07^b	77.20^a±0.56	62.11^a±0.53	67.44^a±0.23
T_2	62.23^b±0.58	19.62±0.08^b	18.93±0.21^b	78.23^a±0.26	62.89^a±0.22	67.63^a±0.35
T_3	62.77^b±0.63	19.77±0.35^b	18.40±0.09^b	78.00^a±0.71	62.29^a±0.49	67.51^a±0.65
T_4	62.06^b±0.26	20.05±0.16^b	18.55±0.12^b	77.40^a±0.72	62.96^a±1.76	67.96^a±1.40
T_5	62.57^b±0.41	19.97±0.15^b	19.09±0.03^b	77.39^a±0.84	62.14^a±0.56	67.14^a±0.42
T_6	61.89^b±0.69	18.38±0.06^a	16.93±0.20^a	74.42^b±0.19	58.18^b±0.12	63.24^b±0.28
T_7	61.92^b±0.51	18.61±0.28^a	16.85±0.06^a	74.47^b±0.04	58.85^b±0.26	63.96^b±0.16
T_8	61.94^b±0.24	18.82±0.05^a	16.85±0.31^a	74.66^b±0.41	58.61^b±0.18	63.29^b±0.15
T_9	62.33^b±0.52	19.91±0.23^b	18.78±0.36^b	77.97^a±0.41	62.34^a±2.12	67.35^a±1.67
T_{10}	58.85^a±0.38	18.38±0.05^a	16.79±0.12^a	74.30^b±0.25	58.34^b±0.15	63.37^b±0.09
T_{11}	58.51^a±0.20	18.62±0.29^a	16.80±0.31^a	74.66^b±0.10	58.68^b±0.24	63.59^b±0.36
T_{12}	59.36^a±0.24	18.82±0.06^a	16.83±0.27^a	74.53^b±0.10	59.00^b±0.21	63.14^b±0.18
T_{13}	59.23^a±0.27	19.73±0.41^b	18.79±0.29^b	77.40^a±0.64	62.29^a±0.71	67.26^a±0.66

Means bearing different superscripts within a column differ significantly (P<0.05); NS=Non significant; T_1=Basal diet; T_2=15% of soybean meal replaced with DDGS; T_3=15% of soybean meal replaced with DDGS+0.50% lysine, T_4=15% of soybean meal replaced with DDGS+0.75% lysine; T_5=15% of soybean meal replaced with DDGS+1.00% lysine; T_6=30%of soybean meal replaced with DDGS; T_7=30% of soybean meal replaced with DDGS+0.50% lysine; T_8=30% of soybean meal replaced with DDGS+0.75% lysine; T_9=30% of soybean meal replaced with DDGS+1.00% lysine; T_{10}=45% of soybean meal replaced with DDGS; T_{11}=45% of soybean meal replaced with DDGS+0.50% lysine; T_{12}=45% of soybean meal replaced with DDGS+0.75% lysine; T_{13}=45% of soybean meal replaced with DDGS+1.00% lysine

of Wang *et al.* (2007a) who reported no negative effect of feeding 15% DDGS on carcass quality of broilers, Choi *et al.* (2008) concluded that the use of DDGS in broilers diet up to 15% had no negative effect on growth performance and meat quality, Ghazalah *et al.* (2012) reported that there was no significant effect on carcass traits up to 60% replacement of soybean meal with DDGS. The treatment groups having 30 or 45% DDGS replacement levels but lower level of lysine (less than 1%) had lower (P<0.05) dressing, eviscerated percentages as well as lower drawn yield. These results may be due to the fact that lysine has a profound effect on productivity.

The study concluded that the dry matter metabolizability was not affected up to 30% replacement level of soybean meal with DDGS. No significant negative effect was seen on nitrogen retention, gross energy metabolizability and moisture or ether extract of muscles. But the dietary supplementation of less than 1% lysine at 30 and 45% DDGS replacement levels had negative effects on muscle protein content. If, the lysine was properly balanced in the ration, up to 45% of the soybean could be replaced without any negative effect on the carcass characteristics.

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